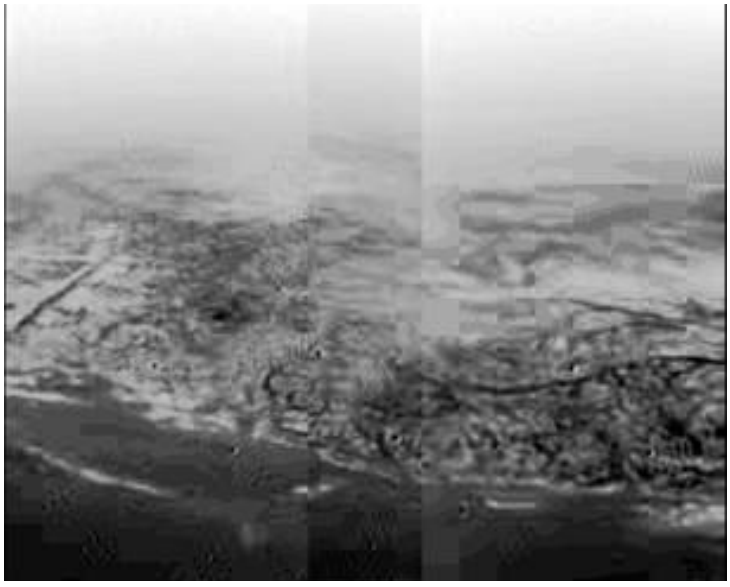
Editorial

Extraterrestrial environmental physics was very much in the news in January 2005 when the European Space Agency's Huygens probe touched down on the surface of Titan, the largest moon of Saturn. During its descent the probe measured Titan's atmosphere, including temperature, pressure, wind, aerosols and electrical properties. On landing, the Open University's Surface Science Package measured the physical characteristics of the surface. The Descent Imaging Spectral Radiometer instrument (DISR) beamed back some of the first pictures of an alien environment appearing superficially similar to our own, with hills, "islands", liquid drainage channels and even a "beach". Mission scientists are busy with data analysis and no doubt further astonishing features of this barren world of methane and ice will be revealed in due course.

One of the first pictures to be sent back from Titan

Should the remit of the Environmental Physics Group be extended to other worlds? What do group members think? Contact the Editor, Karen Aplin with your news and views.



Whatever this image may suggest, life would most definitely not be a beach on Titan as surface temperatures are -178 ºC

Images from the European Space Agency. More information on the Huygens mission is available at:
http://www.esa.int/SPECIALS/Cassini-Huygens/index.html

Environmental Physics Group Notices

14th Annual General Meeting

Wednesday 11th May 2005
5.45pm
Lovelace Room, 76 Portland Place, London

AGENDA

(1) Welcome

(2) Chairman's Report.

(3) Secretary / Treasurer's Report.

(4) Committee Elections

(5) Essay Competition

(6) AOB

Forthcoming Essay Competition

The Environmental Physics Group is planning to hold an essay competition, which will be announced formally at the Annual General Meeting. We are likely to invite entries in the form of an article on any aspect of environmental physics, which should be understandable, for example, by an interested member of the general public. Further details will be available at the AGM.

Environmental Physics Group Bursary Scheme

This scheme is open to all members of the Environmental Physics Group. It is particularly, but not exclusively, aimed at supporting student and post-graduate members or those with low income. Bursaries are only awarded in support of meetings and events organised or co-sponsored by the Environmental Physics Group and are intended to provide a contribution towards the travel or registration costs associated with the event. Successful applicants are expected to write a report of the meeting for publication in the Group's Newsletter.

To apply for a bursary, contact either the organiser of the meeting as advertised, or the Vice-Chair of the Group, with an outline of the details of the request. Applications should be made in good time before the meeting in question. A member of the Group may receive no more than one of these bursaries in a calendar year. The number of bursaries awarded in a calendar year is limited.

Environmental Physics News

Congratulations

A second member of the EPG Committee has won a prize. Congratulations to Paul Williams who was awarded the Royal Astronomical Society's Blackwell Prize for his DPhil. Thesis, entitled *Nonlinear interactions of fast and slow modes in rotating, stratified fluid flows,* which was awarded by Oxford University. Paul's summary of his research is reproduced from the Royal Astronomical Society website below.

I studied the behaviour of waves in the Earth's atmosphere. Rossby waves are responsible for the familiar pressure variations seen on weather maps, but the atmosphere also contains inertia-gravity waves, which are much smaller in wavelength. It was conventionally thought that Rossby waves and inertia-gravity waves did not significantly interact with each other. This was convenient for atmospheric modellers because inertia-gravity waves are too short to be explicitly included in computer models.

Paul Williams receiving his prize from Prof Kathy Whaler, President of the Royal Astronomical Society, with William Herschel looking on.

During my D.Phil. I used a laboratory experiment to show that inertia-gravity waves are actually able to cause major transitions in the spatial patterns of the Rossby waves. This was direct evidence that the interaction could be stronger than previously thought. I also showed that the transitions could be simulated in computer models by including a stochastic representation of the inertia-gravity waves. This finding adds to the evidence that numerical models of planetary atmospheres may be improved by adding random noise, a counter-intuitive concept that meteorologists are beginning to take seriously.

I currently hold a postdoctoral Research Fellowship in the Centre for Global Atmospheric Modelling at Reading University. My research forms part of a

UK-wide programme which aims to improve our ability to quantify the probability and magnitude of future rapid changes in the Earth's climate. This involves a study of the physics not only of the atmosphere, but also of the ocean, and of interactions between the two. Of particular interest is the ocean's thermohaline circulation, which may rapidly collapse in response to anthropogenic greenhouse gas emissions.

Marine Processes and Climate in UK Waters

The “Marine Processes and Climate” report is an Inter-Agency Committee on Marine Science and Technology (IACMST) document produced as part of the UK Government’s “UK State of the Seas Report”. It describes the present status, trends and changes in marine processes and climate within UK waters.

To access an interactive web version or a pdf version, please go to the OceanNET website (www.oceannet.org) and click onto “Climate Reports”.

Graham Alcock, Consultant to the IACMST (grahama@onetel.com)

Applied Physics and Technology Division Prize

The Applied Physics Division, of which the EPG is a member, offers an annual student prize. Nominations may be made by member groups for the student who has, in their opinion, made a significant contribution to the group activities in the past year (1 October – 30 September). Forms are available from the Secretary and the nominations must be submitted bv 30th September.

Newsletter on Atmospheric Electricity

The deadline for the 2005 Spring issue of the NEWSLETTER ON ATMOSPHERIC ELECTRICITY is close. We would like to remind you that this Newsletter presents twice a year (November and May) to the members of our community several kinds of information: (1) announcements concerning people from our community, especially awards, new books... (2) announcements about conferences, meetings, symposia, workshops in our field of interest, (3) brief synthetic reports about the research activities conducted by the various organizations working in atmospheric electricity throughout the world, and presented by the groups where this research is performed, and (4) a list of recent publications. In this last item will be listed the references of the papers published in our field of interest during the past six months by the research groups that wish to release this information, but we do not include Conference proceedings. No publication of scientific paper is done in this Newsletter. We remind you that the Newsletter is now routinely provided on the web site of ICAE (http://www.Atmospheric-Electricity.org)**,** and on the web site maintained by Monte Bateman http://ae.atmos.uah.edu.

Therefore, we urge all the groups interested to submit a short text (***one page maximum***) on their research, their results or their projects, along with a list of

references of their papers published during the past six months. This list will appear in the last item. Any information about meetings, conferences or others we would not be aware of will be welcome. The due-date for such submissions is May 15th. Your text should preferably be sent by Email, as an attached document (word document is preferable), at my electronic address: serge.soula@aero.obs-mip.fr

Serge Soula, Secretary to the International Commission on Atmospheric Electricity, Université Paul Sabatier, Toulouse

New IoP policy paper, "Climate Change Prediction: a challenging scientific problem"

"The claim of man-made global warming represents the descent of science from the pursuit of truth into politicised propaganda. The fact that it is endorsed by the top scientist in the British government shows how deep this rot has gone."

These words come from Melanie Phillips, an English graduate with no scientific qualifications, in an article published in the Daily Mail on 12 January 2004. In her article, Ms Phillips argues that "much of the research behind this [global warming] theory is specious, anti-historical and scientifically illiterate". She mistakenly claims that the climate record "only goes back a few centuries" (in fact it goes back at least one million years) and that it is "surely a cause for rejoicing" that the climate has recently warmed by 0.6 degrees.

It is with the above quotation that a new Institute of Physics policy paper opens, intended to tackle sceptics who doubt the models scientists use to predict future climate change. Written by Professor Alan Thorpe, Chief Executive of the Natural Environment Research Council and one of Britain's leading climate change experts, the report aims to convince policy-makers, the general public and the scientific community that the threats posed by global climate change are real. The Institute hopes that the paper will increase believability in climate models, and be persuasive that anthropogenic activity is causing global warming.

The report hypothesises that the fact that everyone experiences weather and climate may explain why non-scientists feel confident in attempting to refute the scientific evidence. But the complexity of the climate system and its many interacting and compensating physical processes means that simple experiential arguments that gloss over this complexity have to be approached with a significant degree of scepticism.

In the report, Professor Thorpe argues that it is lack of knowledge about how climate change is predicted that is the main reason why there is so much ill-informed comment in the media and among the public. And so he sets about explaining the basic physics upon which climate models are built, recognising that although we are sure that Newton's laws of motion apply, the precise

details of how to represent the multiplicity of forces that exist, and how they depend on atmospheric and other properties, is extremely challenging.

The report uses an analogy with the kinetic theory of gases to show that it is probably possible to describe certain gross aspects of climate (for example, global average near-surface air temperature) without recourse to detailed numerical models. A radiative transfer calculation is given as an example of this. But the report then argues that if we want to predict local properties of the climate system and their evolution in time, we need to use sophisticated numerical climate models.

From the viewpoint of knowing whether the physics in numerical climate models is correct, the report notes that climate and weather models are based on the same fundamental physical equations, just solved on different timescales. It argues that the fact that weather forecasting has been done routinely every day for about the last thirty years is significant: weather forecasts are both incredibly successful and useful to society, which is why they continue to be produced even though they involve considerable expense.

The report states that the equilibrium temperature at the Earth's surface depends essentially on three factors: the concentration and vertical distribution of the minor constituents that determine the magnitude of the greenhouse effect; the Sun's output of radiation; and the reflectivity of the Earth to that incoming solar radiation determined by surface, aerosol and cloud properties. It has been shown, by including each factor separately in numerical climate models, that the solar variations that have occurred cannot explain the recent few decades of warming, and that human input of greenhouse gases are most likely responsible for this warming.

Professor Thorpe notes that there is little doubt that there is still some way to go to simulate accurately all facets of the climate system with numerical models. However, the relentless advance in the power of computers means that we are in sight, over the next decade or two, of being able to simulate the global climate with a horizontal resolution of just a few kilometres, which will help reduce substantially major uncertainties such as those associated with the effects of clouds.

The report closes by noting that few if any scientific problems have had such a huge degree of scrutiny by specialists and non-specialists, and that it would seem to be perverse not to take the risk of human-induced climate change very seriously indeed.

The report, "Climate Change Prediction: a challenging scientific problem", can be downloaded from http://policy.iop.org/Policy/HE/index.html

Paul Williams

Meeting Reports

Solar Variability and Climate Change, IoP 20 October 2004

This lecture was given by the holder of the Institute's Charles Chree Medal and Prize, which is awarded annually for distinguished research in Environmental Physics and related fields, Prof. Joanna D. Haigh from Space and Atmospheric Physics, Imperial College London. The content of her talk is outlined below.

Since ancient times, and the observation of variations in sunspot numbers, it has been speculated that changes in solar activity may influence the climate on Earth. The scientific literature provides a large number of examples of studies claiming correlations between different solar and meteorological parameters, although many of these do not stand rigorous statistical analysis and, until recently, the whole subject area was viewed with mistrust, if not derision, by the meteorological establishment. Since the availability of solar irradiance measurements from earth-orbiting satellites, however, it has been established that the solar "constant" is not. Furthermore, advances in computer power have enabled the development of sophisticated climate models that can incorporate many of the relevant processes.

In the talk Prof. Haigh outlined the chequered history of solar-climate studies, reviewed the evidence for an influence of the Sun on the lower atmosphere and discussed recent work, using numerical circulation models at Imperial College, which is unravelling some of the physical mechanisms involved.

Joanna Haigh and Karen Aplin

Beyond global warming theory, IoP 2 February 2005

Beyond global warming theory was the provocative title of an evening talk held at IoP headquarters on 2nd February 2005, by the Energy Management Group who had also invited Environmental Physics Group members. The speaker was Piers Corbyn, on behalf of *Weather Action*, a company producing long-range weather forecasts through analysis of variations in the sun – the "solar weather technique" (SWT). At the outset, Mr Corbyn described what he saw as "political issues", which he felt dominated the discussion of climate change. He argued that, because of these, global warming was not a well-posed scientific question and the regulatory steps associated with the Kyoto Agreement had not been made on a scientific basis. He felt that the motivation for concern over Global Warming was driven by a combination of the pro-nuclear lobby, climate scientists seeking continued funding, and pro-carbon levy industrialists: this group he generically described as the "Global Warmers". The rest of the talk concerned alternative explanation to atmospheric carbon dioxide as the major source of climate

change, which concentrated on the empirical evidence for a dominating effect of the sun.

A series of plots were presented which showed correlations between variations in geomagnetic parameters and climate parameters. These included the geophysical *aa*-index and global temperature, the latter from the instrumental record or isotopic measurements using ice cores. Using these data, statistical associations between geomagnetic parameters and climate were produced. Wandering of the magnetic north pole was suggested to be associated with climate: a wandering of the pole northwards was linked to global warming, and southwards, global cooling. The correlated changes in the terrestrial magnetic field and global temperature could be described by a "temperature-particle link function". The global temperature changes were explained to result from changes in the position of the Gulf stream, linked to the earth's spin rate, modulated by solar activity. As well as the Gulf stream, it was also said that particles from the sun controlled El Nino and the quasi-biennial oscillation of stratospheric winds.

A succinct summary of what was presented might be that, whilst conventional meteorology deals with how the atmospheric circulation leads to local weather, the SWT aspires to deal with predicting the general form of the circulation patterns. The SWT apparently does this by hypothesising the existence of "Solar Activity Magnifiers" (SAM) in the atmosphere. It was not made clear what SAM are physically, or indeed if anything specific is known about them. The interpretation of Global Warming presented was that somehow SAM modulate the "primary" greenhouse gases water vapour O_3, N_2O and NO_3, causing global temperature changes to which the secondary greenhouse gases of CO_2 and CH_4 respond. The causal sequence of changes is therefore fundamentally at odds with an understanding based on CO_2-induced global temperature changes, as reflected in the title of the talk.

Moving on to a discussion of long-term weather forecasting using the SWT, Mr Corbyn drew attention to a reliable prediction of the Carlisle floods of January 2005 by *Weather Action*. On the topic of reliability, he mentioned that, by betting £600 monthly on the SWT forecasts, he had made a net profit of £14,000. It is very arguable whether this constitutes a useful method of forecast "verification", but it is no longer possible, as Mr Corbyn has been banned from betting at the bookmakers William Hill for 3 years. Mr Corbyn drew attention to an independent study on the SWT. A short period of Weather Action's UK **gale** forecasts "…reveal a degree of success that cannot readily be accounted for by chance…" (see Wheeler D., A verification of UK gale forecasts by the 'solar weather technique': October 1995-September 1996 *J.Atmos Sol-Terr Physics* **63**, 29-34, 2001) The gale forecasts were chosen as they were relatively objective: it is known to be difficult to assess weather forecasts produced in qualitative terms or for varying time intervals or regions (see Jolliffe I.T. and Jolliffe N., Assessment of descriptive weather forecasts *Weather* **52**, 391-296, 1997).

As a whole, this was a lively, even flamboyant talk, although at times the slides were densely packed with material very difficult to assimilate. Many

questions followed, concerning the presentation of the data and clarification of what the plots actually showed (some axis scaling was arbitrary), the statistics of the findings and the physical mechanisms of the particle-atmosphere changes. There were some amusing and perhaps irreverent asides: in one the physics of a global climate model was compared to “a model of fudge cake” and in another, the many widespread observations of global dimming were dismissed as “nonsense”. Asked about the paradox of sun-weather correlations deserving more confidence than carbon dioxide global temperature “correlations”, Mr Corbyn pointed to details in carbon dioxide changes which he felt were incomplete.

From my own perspective, many fundamental questions provoked about the underlying atmospheric physics remained unanswered. And quite apart from whether *Weather Action*’s statistical links between the sun and climate are shown to be robust, can the solar changes themselves, on which the statistical climate forecasts clearly depend, be reliably predicted?

Giles Harrison

Waste Minimisation & Resource Efficiency: The Role of Physics, IoP 23 March 2005

Staggering statistics got this meeting underway. Material consumption in the UK is currently running at 650 million tonnes per year. The total figure for generated waste is 450 million tonnes per year; furthermore, this is growing at 3% per annum. With new legislation governing landfill and how to deal with vehicles and electronic equipment at the end of use about to come into force, the audience were left in no doubt that waste minimisation is a topic gaining in significance and is one in which physicists should be actively engaged.

Although the meeting focussed predominantly on science and technology, the first speaker, Professor Stevens (University of Surrey), reinforced the view that policy-related, logistic and other commercial factors are also very important. He described the application of Life Cycle Management (LCM) tools for systems optimisation, particularly related to plastics recycling. As well as considering environmental impacts, such tools are developing to include economic and social factors more rigorously.

Most of the speakers concentrated on a particular technology either with proven or prospective use in waste minimisation. In a presentation on space-borne remote sensing, Guiseppe Ottavianelli (Cranfield University) discussed several possibilities for its application in landfill management, including site characterisation, emissions and leachate monitoring and illegal site detection. Spectral and spatial performance factors are key. The development and application of fuel cells, from the 1840s to the present day, was covered by Paul Christensen (University of Newcastle). Although barriers to their widespread uptake remain, including cost, power and public perception, current large levels of investment across the globe may bring the step change in technology that will lead to significantly wider application.

In a talk on the use of atmospheric plasmas, Chris Whitehead (University of Manchester) outlined the potential for remediation of gaseous waste, including from landfill and industrial processes. One particular advantage of the technique is the ability to recover specific materials of economic value, such as organo-metals, from a waste stream. Further presentations considered sustainability issues in the consumer electronics industry and the role of the Mini-Waste Faraday Partnership in achieving improved environmental performance by industry, through the adoption of new technology.

Several new funding streams present an opportunity for researchers to engage with this rapidly growing area. Despite some difficulty in finding the practitioners of physics in waste minimisation technologies, a varied and appreciative audience enjoyed the meeting and found it extremely worthwhile – thanks to Andrew Rowley for organising it.

Peter Hodgson

Forthcoming Events

Investigations into Soil Architecture
Wednesday 2 November, The Institute of Physics, London

This half-day meeting will be held on Wednesday, 2 November from 13.30 to 17.30 hours at the Institute of Physics. It will be a joint venture between the EPG and the British Soil Water Physics Group and organised by Edward Youngs and Derek Rose.

In contrast to the many meetings that have discussed the modelling of porous structures, this meeting will focus on recent advances in visualising, measuring and analysing the internal structure of porous materials, particularly the pore space, by non-invasive techniques such as computer-aided tomography and nuclear magnetic resonance as well as by more conventional electron and optical microscopy. In addition, the utility of such information will be discussed.

We aim to have five or six speakers to cover the subject matter. There will be invited contributions from the University of Abertay, Queen Mary College and Rothamsted Research. We invite offered papers from active researchers in this field. Offers of papers, with a short abstract, should be sent to Edward Youngs at e.g.youngs@cranfield.ac.uk

History of Air Pollution
Wednesday 30 November, Dirac House, Bristol

This will be an interdisciplinary afternoon meeting organised jointly with the History of Physics Group and the South West Branch of the IoP. The history of air pollution is a fascinating topic and one that is relatively little-researched scientifically. It holds relevance for studies of past air composition, meteorology and health as well as general historical and scientific interest.

Invited speakers will include: Prof. Peter Brimblecombe (University of East Anglia), whose book *The Big Smoke* is well-known, Dr Stephen Mosley (University of Birmingham), who researches the social history of air pollution, and Dr Giles Harrison (The University of Reading) who has studied historical measurements of air pollution.

It may be possible to display posters of related research work. Please contact Karen Aplin k.l.aplin@rl.ac.uk for further information.

Electric Fields and Discharges for Microbiology and Health Care Applications
19 May 2005, Institute of Physics, London

Electric fields and discharges have long been known to influence many aspects of cell and micro-organism physiology, metabolism and viability. Today, multidisciplinary research is widely undertaken by scientists from many disciplines seeking to manipulate cells, understand their responses to fields and discharges, and to disinfect the air, surfaces, food stuffs and fluids from micro-organisms. The Electrostatics Group of the Institute of Physics is hosting a meeting to bring together interested parties from academia, industry and health care to communicate recent progress in this field and discuss its implications to future applications. The meeting will include discussion of research into pulsed electric fields for both sterilisation applications and cell manipulation, and the use of ionisation for sterilisation and infection control.

Bursaries
A number of bursaries will be available to assist PhD students and new post doctoral researchers in attending, sponsored by Children with Leukaemia and the Electrostatics Group of the Institute of Physics. For further information please contact:

Dr Lindsey Gaunt
School of Electronics and Computer Science
University of Southampton
Southampton. SO17 1BJ.
Tel: 023 8059 5163
Fax: 023 8059 3709
E-mail: lfw@ecs.soton.ac.uk

To obtain a full programme and Registration please visit the following web page: http://conferences.iop.org/EFD

Half-day IoP Optical Group meeting on Fourier Transform Infrared Spectroscopy

followed by the NERC Molecular Spectroscopy Facility Users' Meeting

Thursday 30 June, Rutherford Appleton Laboratory, Didcot, Oxon

The meeting is intended as a forum for presentation and discussion of current developments in Fourier Transform Infrared (FTIR) Spectroscopy. The meeting will encompass a wide scope including developments in FTIR instrumentation, detectors, sources, analytical procedures and applications. The half day meeting will be held at the Rutherford Appleton Laboratory immediately before the NERC Molecular Spectroscopy Facility's (MSF) annual User Group meeting to facilitate technical exchanges between participants in these two events. A tour of the Molecular Spectroscopy Facility will be offered at midday highlighting the MSF's own FTIR spectrometers. Lunch for participants at either the IoP half day and/or the MSF User group meeting will be sponsored by Bruker Optics.

Oral and poster presentations are solicited on a broad range of topics related to Fourier Transform Infrared Spectroscopy. Written papers are not required. Suggested topics include:

- Developments in FTIR instrumentation
- Characterisation of FTIR performance
- Analytical procedures
- Developments in absorption, reflectance and emission spectroscopy
- Industrial FTIR applications
- Atmospheric remote sensing by FTIR
- Open path measurements
- QA/QC procedures

Deadline for submission of 200 word abstracts is **30th April 2005.** This meeting is organised by Moira Hilton (University of Reading) from whom more details can be obtained.

Dr Moira Hilton
J J Thomson Physical Laboratory
University of Reading
Whiteknights
Reading, RG6 6AF
Tel +44 (0)118 378 8539,
Fax +44 (0) 118 975 0203

email m.hilton@reading.ac.uk

"Out of the Blue"
NERC Marine and Freshwater Microbial Biodiversity Finale Event
Tuesday 24 May, The Royal Society, Edinburgh
Thursday 2 June, Queen Elizabeth Conference Centre, London

The finale event will showcase the results of research, funded through the Marine and Freshwater Microbial Biodiversity (M&FMB) Programme, into the diversity and function of aquatic microbes and their role in ecological systems. The results are applicable to a range of fields and the event is intended for a wide audience, including those in central and local government, conservation agencies and NGOs, and biotechnology-based industries.

The event is open to anyone who is interested in the work of the programme and is being run in both London and Edinburgh. The event will include talks and panel discussions and there will be plenty of time available to ask questions and for informal discussions. The scope of the programme's work has been varied and key highlights include:

- Role of aquatic microbes in global cycles and climate change
- Bio-prospecting for novel natural products
- How bacteria communicate in biofilms
- Discovery and cultivation of new microbe groups
- The role of virus DNA in oxygen production

The result of this research has great potential for exploitation, including new drugs to combat MRSA, ways to prevent biofouling, and products for industrial processes.

More information on the M&FMB Programme can be found at www.nerc.ac.uk/m&fmb

If you would like to register for the event please contact the NERC Conference Desk (nerc@vistaevents.co.uk or fax: 020 8542 9333)

Optical Environmental Sensing

Thursday 6 October 2005
Photonex05, Stoneleigh Park, Warwickshire, UK

The meeting is intended as a forum for presentation and discussion of current developments in Optical Environmental Sensing and is being organised jointly by the IoP Optical and Environmental Physics groups. The meeting will encompass a wide scope including new developments in optical measurement techniques and novel optical methods for monitoring the atmosphere, clouds and the terrestrial environment. Remote optical sensing techniques are already widely used for quantifying atmospheric constituents from the ground, air and satellites. Ground based or in-situ environmental monitors utilising optical techniques such as fibre optic probes, UV, Visible and IR spectroscopy, and tunable diode lasers are being applied to monitor

the environmental impact of transport, industrial processes, waste management and compliance with government regulations. The development of optical techniques to monitor particulate/aerosol compounds of micron and submicron size range are increasingly of interest.

Suggested topics for oral presentation, to include but not necessarily limited to

- Novel optical sensors for gas, liquid or solid phase
- Particulate/aerosol optical sensors
- Design and testing of optical sensors
- QA/QC of optical techniques
- Radiative transfer and inversion methods
- Terrestrial optical remote sensing from ground, air and satellite
- Optical sensors for industrial process monitoring or control
- Optical methods for environmental impact assessment

Prospective authors should advise us of the Title by **15 June**, and submit abstracts of 200-400 words (half to one page) by **15 July** including the names of the authors and their affiliations, and indicating the presenting author, accompanied by the form below, and preferably send the same information by e-mail. To receive further information, please return this form.

Name: _____ *Organisation:* _____

Address: _____

_____

Tel: _____ *Fax:* _____ *E-mail:* _____

My/our abstract title will be:

_____

_____

Please tick as appropriate:

My/our Abstract will follow ☐ I would like to attend - please keep me informed ☐

Please send to Dr Moira Hilton, J.J.Thomson Physical Laboratory, The University of Reading, Whiteknights, Reading, RG6 6AF, U.K. t:+44(0)118 3788539 f:+44(0)118 9750203 e: m.hilton@reading.ac.uk ***or***
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